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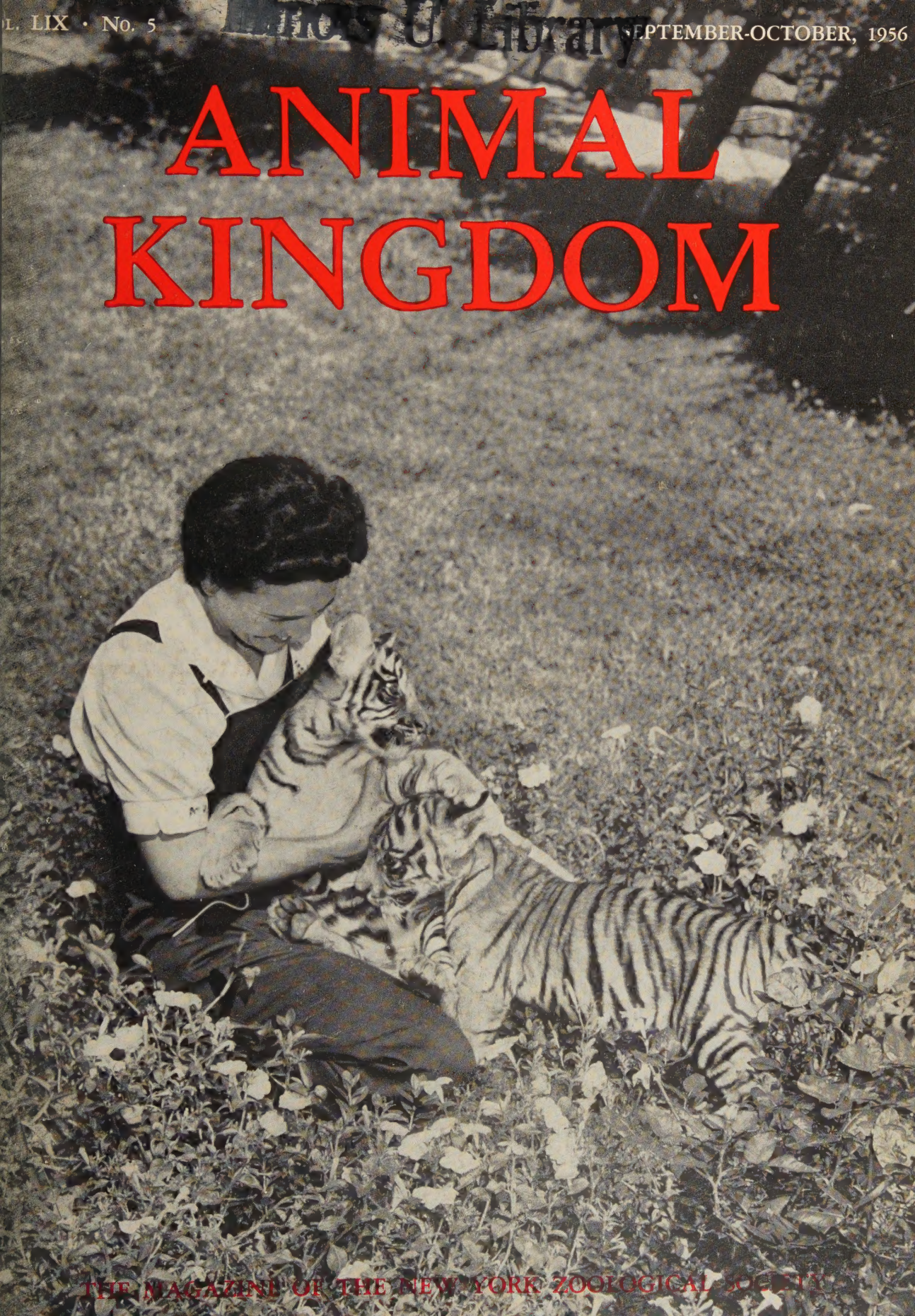
# ANIMAL KINGDOM



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# ANIMAL KINGDOM

**Bulletin of the New York Zoological Society**


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# No Limits to Science

IN A POLITICAL SENSE, the concept of "far-flung empire," through long centuries a reality, is now becoming obsolete. In a scientific sense, there are no visible limits, either terrestrial or celestial, to the expanding empires of knowledge which the scientist is constantly building.

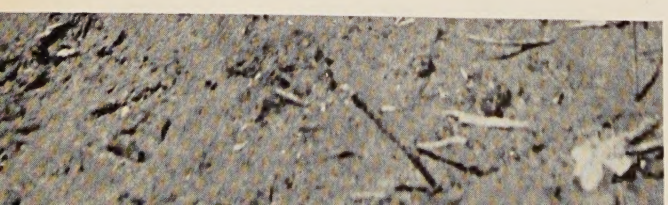
These thoughts are evoked by the contemplation of the work of our own institution. Either afield or in the laboratory the members of our scientific staff, like all other scientists, are forever in search of additional knowledge to be gained only through the exploration of new regions of thought and of space.

In regard to scientific work in the field, a current activity of our Society vividly illustrates the above observations. This is the work of a member of our Tropical Research Department, described in this issue, involving studies of the evolution and behavioral characteristics of a single genus, Uca, commonly known as the fiddler crab. This remarkable little animal has established itself on the temperate and tropical shores of every continent. These studies were initiated more than ten years ago and are now approaching culmination in field observations in remote and widely separated regions. Two years ago observations were being made on the shorelines of South America bordering the Atlantic; last year, in the region of Singapore along the littoral of the South China Sea; presently, in the far reaches of the Pacific from Fiji eastward to the Philippines.

Scientific work in the laboratory is similarly a process of invading new horizons to establish fact or theory. Either in the physicist's exploration of the universe or the biologist's exploration of life processes on this very small planet, the scientist's "empire" is forever far-flung.

Fairfield Osborn

*Studying living crabs in Malaya is not an arm-chair job. This is the way Miss Crane does it — photographing the daily lives of these tiny creatures on reeking mudflats in Singapore.*



# In Malaya

# Looking f

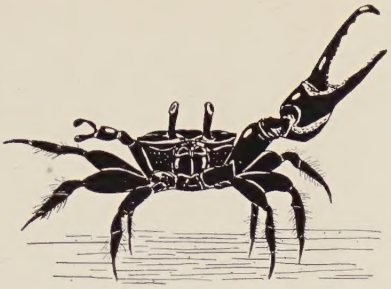
By JOCELYN CRANE

*This article was written by Jocelyn Crane of our Department of Tropical Research when she returned from Malaya last year. Now she is on the second expedition of her round-the-world investigation of fiddler crabs, working in Fiji, Tahiti, Australia and the Philippines.*

To most people a crab is merely the major ingredient of a fairly festive dish. To some it is a bit of fish-bait with a tendency to pinch. And to a few of us it means a particularly interesting kind of animal. In fact, members of one family — the fiddlers, ghost crabs and their allies — promise help in solving so many scientific puzzles that it was worth a trip to Malaya to see thirty-two kinds of them in action.

Almost all the family members are lively and alert. The males often fight one another enthusiastically, and many wave their claws and stretch and bow in a fine variety of displays. Some of these performances, like the songs of many birds, both warn off rivals and play parts in courtship.

All the ghost crabs and fiddlers of America are quite specialized. While they are a wonderful lot, they are unhelpful in yielding clues to the basic evolution of the group. I had studied them for years, from Connecticut to Rio and from California to Ecuador, but it was like trying to trace the family history of dogs from a kennelful of greyhounds and pekinese. It seemed certain that the ancestral path of crab migration had been across the tropical Pacific, from the shores of far Malaysia. To learn the origins of their varied habits and structural adaptations, the only hope was to go out there and try to find, alive and at home, their various relations.

# lues to  Evolution

Already available for study were the preserved bodies of crabs collected on expeditions going back a hundred years. In the United States National Museum in Washington were rows and rows of neatly labeled jars. Similar collections stood in the big museums of Europe and the British Commonwealth. Inside the jars were the faded shells and shrivelled eyes of crabs from all the fabled coasts of the East, from Ceylon and Calicut, the Andamans, Brunei, Celebes, Siam. The scientists of the famous oceanographic ships of the eighteen hundreds — the men of the *Alert*, the *Albatross*, the *Investigator* and the rest — had done their difficult jobs well. Large collections were the first essential for a basic understanding of the animal kingdom.

So the crabs had been gathered, to be laid out months or years later on white enamel trays, giving off an unmistakable aura of alcohol-soaked crustacean. The specialists to whom they were entrusted, in London or Paris, Washington or Leiden, would sort the crabs and measure them, patiently compare and describe. Often the authority was a frock-coated savant who never had the luck to see a coconut palm, or himself dig a prize crab from deep in a muddy hole. Necessarily his published descriptions were based only on distinctions that lasted through the years: "Front one-eighth carapace breadth; oblique ridge on manus of major cheliped ending at carpal cavity; carapace strongly narrowed backward . . ." Attached to the beast itself would be a label, giving the crab's name, the expedition, the collector's name, and then something like "January 17, 1888; low tide; Amboina, Banda Sea."

Well, all right, but what was the crab doing on that January day? Was it interrupted in the middle of a fight? What color was its waving claw? Did it wave at all in a formal display? If so would it be of a primitive simplicity?

A very few of the early collectors had been naturalists as well. There were Alcock and Kemp of the Indian Museum, for instance. Working in the early nineteen hundreds, they faithfully recorded many facts about the general habits of Indian species. Occasional observers since in South Africa and Ceylon, Tangiers and Formosa, have brought out a few tantalizing papers, each on some aspect of strange behavior in one or several local forms. Mr. M. W. F. Tweedie, the present director of the Raffles Museum in Singapore, has contributed more on habits than all the rest. Yet, as he has said, a beginning has scarcely been made. In fact, nothing in the way of a systematic comparative study of the living crabs could be attempted by workers who, by the very nature of their various professions, were confined to single areas.

For a long time I had hoped to tackle the problem as a whole, to follow those labels back to their origins, to go into the mists of the family's past by doing detective work on their present. Only thus might one reach an understanding of how they came to be as they are. That, in turn, should shed light on the principles underlying the evolution of other animals as well.

Years ago Dr. Beebe went to the East to make a comparative study of living pheasants on the spot — one of the first and still few groups of animals ever to be so surveyed. With his encouragement and that of Dr. Osborn, and of Dr. Schmitt and Dr. Chace of the U. S. National Museum, I applied for and received a grant from the National Science Foundation. Thanks to it, a trip to Malaya in the summer of 1955 has been completed and two more are scheduled, to Africa and the South Pacific. Both in the preparations and in Singapore, Mr. Tweedie's friendly help was of the greatest value.

On this trip, the collections of the old days

were supplemented and the live crabs studied on the spot, all from a modern point of view and with more recording equipment than used to be possible. For example, the motion picture camera was used freely in recording the behavior, environment and color phases of the crabs; the best of the crab grounds were visited again and again to study territory, social relations and seasonal changes in behavior. Some individual crabs, marked in bright yellow paint, became as familiar as the coolie who sold noodles on the edge of the swamp.

Even collecting was a different kind of job. In the old days, when a yacht or survey ship anchored off a tropical coast, the man who collected crabs was as likely to be the expedition's archaeologist or botanist as the overworked zoologist. The collector, whatever his specialty, would wander along the shore, perhaps merely while waiting for the dory to take him and his own collections back on board. However, bound to improve each minute in that far land, he would zealously gather a few of the largest crabs in sight. These might turn out to be the only ones of their kind, when months later they ended up on the desk of a carcinologist. Nowadays it is clear that the largest crabs of a given sort are not the most characteristic. To describe a new species from a few of these elderly monsters is like publishing an account of *Homo sapiens* based on a row of department store Santas. Therefore on the Malayan trip large collections of all sizes were gathered of every species possible.

And always I tried to find the answers to the major problems: Did the family really originate in the East? How and when did all those species come to differentiate? How do so many closely related species live together without hybridizing? Or do they hybridize sometimes, in some places? From what archaic scraps of behavior – a feeding gesture? a threatening lurch with a brandished claw? – did they build up their complex waving rituals? Do the glowing colors, blue and yellow, white and red, mean anything as signals in their lives? And, above all, are any of them truly primitive? Can any be living fossils?

The answer to the last question was a bang-up surprise that hit me when I least expected it.

Some of the most attractive animals today can boast of being living fossils – old-fashioned members of their tribes who have somehow survived up to nowadays. Cecil and Penelope, our famous Bronx Zoo Platypuses, belong among them, but their grace and appealing furriness are not what make them evolutionary showpieces. The Tuatera, the New Zealand rhynchocephalian so much admired in our reptile collection, has an unforgettable, bright-eyed look that does not, however, extend to the exciting remains of its ancestrial third eye. The few who have seen it alive vouch for the beautiful blue of the African coelacanth, that survivor of an ancient tribe of fish. And if the Abominable Snowman should turn out, as some wistfully hold, to be a surviving cousin of Neanderthal Man, he will doubtless prove to have attractions which are unguessable from the stolid bones of his ice age kin.

It is that way with a heretofore obscure crab which, among the wide and lively tribe of fiddlers, should surely take precedence as a true primitive. At a glance, the most and perhaps the only attractive thing about it for human beings, is its color, which tends in its youth to be splashed with scarlet. Even the crab's eyes, and sometimes the eyes alone, glow with color from the darkness of the mud. Yet, like the other living fossils, these attractive assets of color are not what make the crab scientifically interesting. In fact, it seemed such a doltish creature that I tended for the first three weeks in Malaya to skimp on it altogether.

Everything about that crab, except its cheerful color, was lumpish. Its large cheliped was rather stocky, with stubby fingers. Its legs were short and weak; apparently they could not support the chunky body for more than a few instants. Whereas other fiddlers race about on tip-toe, defending territories, fighting rivals and chasing females with grace and gusto, this phlegmatic creature moved very little as it fed from the mud, and then with no more verve than a somnolent hippopotamus. Even the scarlet color faded out by the time the crab reached an inch or so in length; thereafter it relapsed into drabness, a purple smear across the claw being, to human eyes, its one remaining claim to glamor.

Nevertheless it was at the crab's scarlet best that I came suddenly one day to appreciate its sterling scientific worth. It was on a warm July afternoon near the Singapore airport. The big planes for Hongkong and Bangkok, Colombo,

***Typical of the habitat of the fiddler crabs is this spot on Singapore Island. It is a morass of mud and mangroves, washed by brackish water; here the crabs teem by the thousands.***

Karachi and the unimaginable reaches of Europe and America raced down the runway several hundred yards away. They did not bother either the crabs or me, for our world was the small patch of sand and mud and mangrove along the Geylang River. As usual, *Uca manii,* the red-eyed one, was just sitting, eating.

Suddenly, however, it stopped feeding and faced left. A female had just emerged from her hole a foot away. Slowly, the male brought his large, flexed claw up and down several times, raising it just as far as the level of his eyestalks. Each time he heaved himself a fraction of an inch off the ground on his walking legs. Then there was quiet again. After some three minutes of motionlessness he repeated the triple claw-lift at the slow tempo of one heave every two seconds. It had such a ponderously unenthusiastic appearance that one expected to hear rheumatic creaks from all his numerous joints. Finally he moved over toward the female, pausing now and then to repeat his unsensational performance. When he reached her, he touched her walking legs with his, whereupon she broke it up by vanishing down her burrow. After that he just sat, for an unconscionably long five minutes, and then dragged himself over to his own hole and resumed his meal.

The procedure was repeated at least several times on each of two successive days, and subsequently I saw it many times with other pairs involved. One couple eventually carried through and mated. In none of the preliminaries did anything either more energetic or more complicated happen and at long last I was convinced that I had been witnessing a fiddler's stone-age-type of courtship which was perfectly in keeping with its archaic structural plan.

In the subsequent weeks there was more evidence. Not only *Uca manii* but two other Singapore species — *dussumieri* and *rhizophorae* — proved to be similar though less extreme primitives. There was a tidy intermediate, *U. marionis,* which sometimes, in the height of excitement, actually unfolded his great claw and waved it above his head like an American fiddler crab. And finally, there were the pink-clawed fiddlers, *annulipes,* which cavorted in more familiar, lively fashion, and so upheld the terpsichorean honor of oriental crabs.

Before the summer was over I had displays recorded in notes and on film of eight of the ten fiddlers I could expect to have found. The ninth

was over in Karachi and the tenth, the Triangular Fiddler, lived on Malaya's west coast. So I flew up to Penang from Singapore.

The Triangle, because of the shape of his shell, the width between his eyes and the form of his great claw, seemed in some ways primitive and in others rather specialized. His waving therefore should be especially interesting.

As we drove out to the mangrove swamp early that morning I hoped for the sunny weather that fiddlers prefer for their displays, and especially I hoped to find a colony of *triangularis*.

The car stopped at the edge of a Malay fishing village. Carrying collecting gear, camera and tripod we hurried along the beach toward the mangroves at the end. There were neat thatched huts on stilts, people in bright sarongs called greetings as we passed, and we picked our way among boats whose staring eyes gleamed with fresh paint. Just ahead of us a man picked up a sea snake stranded by the tide, and threw it out into the bay. Beside the last house there was a pile of refuse which included three yellow and black squillas — distant cousins of shrimps — a good eight inches long, and a castoff octopus in turquoise. Any of them would have been a pride to our new Aquarium. Then we were at the mangroves, their glossy green showing fresh above curving stilt roots and the broad dark spread of the low-tide mud.

Suddenly we saw some tiny bits of golden yellow in the mud. I picked up the nearest and checked it with a pocket lens. There was no doubt: it was *triangularis* itself. In fact, here were thousands of its kind, and the sun was shining brightly. All conditions were right for the work of recording its display.

But here my tale of the Triangle Crab comes to an end as inconclusive as one of those exasperating problem novels. The vexing animals did not display, not once, all that morning or the next. They simply sat in their legions and infuriatingly stuffed mud into their mouths. They doubtless did an excellent job of sifting out the nutriment, but I was in no mood to be impressed. Not

***TOP** — A female fiddler, without a large claw next to a large-clawed male. **CENTER** — A fight tween two male fiddlers. **BOTTOM** — A male the entrance of its burrow in the tide-wet sa*

***The muddy beach at Penang was the home of the Triangle Crab whose display Miss Crane wanted to study — but it refused to display. The boat has "eyes" so it can find its way.***

only did they give no hint of their waving pattern, but they paid no more attention to one another than hurried strangers at an airport snack bar. It simply was not their courting season, and I had to go back to Singapore leaving their behavioristic secrets still locked tightly in their glands and ganglia.

Most other times I had better luck. The summer passed, notebooks filled, and thirty-four hundred feet of motion picture film were hopefully sent home for processing. In the film was the unequivocable record of bits of behavior patterns. In due time these will be studied under a microscope and run repeatedly, at flicker slowness, on a screen. Through this kind of tedious work the evolutionary puzzles will be partly solved and perhaps the origins of even complex activities will come clear. On the film is preserved not bodies but behavior: for example, that really superlative fight of *Macrophthalmus* at Penang, where two males gripped each other for four minutes by a stop watch and tumbled about in such confusion that it was impossible to see what part their large claws played. It had never before been known that this genus fights at all.

The film contains a record, too, of the chimney-building of certain fiddlers, for purposes unknown; of the astonishing behavior of *Dottillopsis* in Sarawak where the little flame-legged crabs ferried mud in their mouths, in tiny packets, at racing speed, to stop their burrows against the tide. Why did they not carry the mud like their relatives, at leisure in a few large loads held in several off-side legs? What was the origin of a method apparently so inefficient? On the film there are also displays by the dozen, repeated many times over to show differences among genera, species and even among the same species in different parts of its range. One widespread fiddler, *U. annulipes,* was filmed all the way from Pakistan and Ceylon to northern Borneo. If current plans work out, it will eventually be the star also in films made in Eritrea and Fiji. The results may show the species on the way to splitting into subspecies, somewhere between Manila and Zanzibar.

Meanwhile I appreciated the extra dividends of strangeness and color and understanding presented indirectly by the crabs. Never before had a purchase of glass jars for specimens been added up for me on an abacus; never had I bought formalin from a shop that also sold pulverized rhinoceros horn, or laboratory towels from a Malay whose chief stock was sarongs. My low stool for mud-sitting came from a Chinese who specialized in good luck signs in scarlet and gold; he also made up, on request, gaily lacquered altars for family shrines. When I lost a trowel for digging crabs, no replacement could be bought.

***When glass jars were needed for preserving some of her crab collection, Miss Crane found them in this "laboratory supply shop" in Singapore. It sold all sorts of wares, from joss sticks to rhinoceros horn.***

So one was forged to order by a Singapore smith in a pointed pandanus hat.

Never before, either, had I sheltered from the rain in a fisheries bureau cottage across a narrow strait from a sultan's palace. On that cottage wall was a sign that brought the eight-year troubles of Malaya very close. In three scripts it forbade carrying any foodstuffs or clothing or flashlights across the straits, lest the communist bandits receive aid and comfort. The troubles seemed close another day, beside another official sign. After a short cut to the airfield from an upcountry mangrove swamp, my car passed a large billboard which triumphantly announced: "You are now entering a WHITE AREA." In the local parlance that meant the neighborhood had been cleared of trigger-happy terrorists. I wondered what we had inadvertently been passing through before—BLACK, which meant forbidden to civilian traffic, or merely GRAY—"use your common sense" and, no doubt, "avoid wandering about in the mud."

Far more typical, however, were the friendly, daily happenings of work in an alien land. At Bedok one morning all the crabs suddenly vanished down their holes and I looked up to find a small Malay girl in a yellow-flowered sarong. She smiled widely and with no introduction at all sang out "My Mommie's gone to Mecca!" And gone she had, too—one of the first women to participate in such a pilgrimage, and her little daughter was justly proud. It was illuminating to realize that she had gone *westward* to Mecca—as far west from her land as that fabled city is east from New York.

Meanwhile the child picked up an old tin and trotted a tactful fifty yards away. There, unasked, she began to catch unwary crabs to add to my collection. She was doing her own good job of helping international relations.

*Mountain Acrobat:*

# THE CHAMOIS

By MARGARET ALTMANN
*Moose & Elk Researcher, Jackson Hole Biological Research Station*

My studies of social behavior in free-ranging animals in the Jackson Hole region of Wyoming led me to visit the Chamois (*Rupicapra rupicapra*) of the Alps. Intelligent and speedy in reactions, these curious inhabitants of the upper alpine regions are so elusive as to permit only sporadic contacts with the native villagers. Legends have been woven around their lives but even the active hunters know little about their habits.

Both the buck and the doe bear horns, but the buck's are slightly stronger and more curved. The Chamois looks like a goat, jumps like an antelope, furnishes, as a great trophy, the "beard" for the Tyrolean hat, and gave the soft leather, "shammy," its name. But in strict scientific fact it is neither a goat nor an antelope, but belongs to a separate group of goat-antelopes. And it has no beard. The so-called Chamois beard is composed of carefully plucked, long, white-fringed hairs growing along the backbone. The "shammy" one buys today is very likely made from domestic sheep or goat skins.

I found that there is no trophy more admired by the mountain villagers of the Tyrol than a good Chamois beard. In the 16th and 17th centuries it was believed that this would give a hunter special strength and endurance; it was a hunter's special privilege to wear a "Chamois beard" on his hat and it was punishable by law for other people to wear it.

I set out to observe the Chamois from a village near Salzburg in the Tyrolean Alps, with the local game warden as my guide in the steep and rugged mountains adjoining the lesser slopes and drainages. We made camp in a mountain cabin: White-cliff Cabin close to the timberline. It was early November and the ground was still free of snow as we climbed. Despite the lack of snow, our provisions were carried by a one-horse sleigh

*Photo Feuerstein Scuol/Schuls*

***TOP — Deep winter snows drive the Chamois dd from the mountains to the valleys. LEFT — In sp small bands drift up to the windswept timberl***

*Top: Photo Schocher Pontresina* *Left: Photo Feuerstein Scuol/S*

with long curved runners, surprisingly efficient at gliding and bouncing over the dried grasses and shrubs on the steep mountainsides.

Thick fog was closing in on the valley as we ascended the narrow trail, and the rocks and scattered tree groups took on ghostly shapes. We saw Chamois tracks in the mud crossing the trail, and then as we emerged from the layer of fog, we reached the cabin nestled below a thousand-foot-high cliff, from whose shining surface the evening sun was reflected brilliantly.

The slopes of mountain pasture were interrupted by stands of alpine fir and spruce, except where a mighty avalanche had roughly cut through the timber. This one barely missed the cabin last year.

These slopes are the habitat of the Chamois flocks. They are highly social animals. In winter, they aggregate in larger herds in the side valleys and lesser slopes, even descend to the village borders when the snow gets too high. In spring

they form smaller bands and drift gradually to the higher, windswept slopes at timberline.

The Chamois bucks remain with the herds for the summer, even when the females give birth to the young. The kids follow their mothers within a few hours after birth, and when the group is grazing they rest or play. Small rocks or tree stumps are favored places for exercise and play. Chamois games are built around the "flight" and "fight" topics, but very early in life the kids show proficiency in steep places. The Chamois doe is often seen resting below the place where her kid is resting. Calls between the mother and the kid are rarely heard, for the group is closely knit and communication is chiefly by sight and scent.

If there is danger, however, the sharp whistle signal of the female alarms every member of the group. Sometimes the kid takes a wrong direction of flight and in the confusion jumps off alone, but soon it learns to stay with the group and depends on speed as a stabilizer on the rocks. How do the Chamois move so surely, so elegantly, over the steep, slippery rocks? Perfect balance in motion is their main secret, but they are aided by their elastic, soft-walled hoofs, which serve as suction cups on the bare rocks.

When the local cattle are driven up in the mountains for the summer, the noise of the cowbells and the clatter of milk-pails make the shy Chamois retreat to the rocky upper regions above the "cowline." In the fall the first snow and cold spell bring unrest to the Chamois. The breeding season is beginning and the bucks leave the bands for solitary wandering. Now they wallow in springs and pools, they rub their horns against shrubs and protruding rocks, and a waxy secretion from two glands, one behind each horn, marks their territory. A mature buck soon forms a harem by joining a band of females. All young bucks, even the yearlings, are driven out of the flocks by the jealous harem-owner and fighting occurs when his threatening gestures are not heeded. At first the fights are usually mock affairs, sparring or display of intention. The horns of the Chamois are designed to tear, not to stab the opponent, but serious fights are rare and occur only when the partners are very well matched.

The bucks are tireless in guarding their harems against intruders of their own species. The shiny, well-rounded appearance of a Chamois buck in the early stages of the rut soon gives place to leaner lines, for he rarely has time to graze or

***e breeding season begins with e first fall of snow and the cks wander by themselves. On rubs and rocks they rub their orns, leaving a waxy secretion om two glands as a territorial ark. A mature buck soon forms s harem from the female bands.***

*Photo Prof. H. Hediger*

***Chamois kids follow their mothers a few hours after birth, and very early in life they show great proficiency in climbing over the steepest rocks. This kid is only about 3 hours old.***

*Photos Prof. H. Hediger*

browse in peace. Ordinarily shy and wary, the buck becomes careless of his own safety during this time. I have seen a game-keeper fool a rutting buck by breaking little sticks and branches in the thicket. The buck quickly ran toward the noise, believing that another buck was trying to approach the harem.

Chamois bucks have a trying time in the rutting season. All their attention is focused upon intruding rival bucks, but the does are alert to warn and move the whole group to safety, if needed. When the fall rut is in full swing, snow flurries and fog often cut visibility but the chances of seeing and observing the Chamois do not diminish. If you know where to find them, you can stalk them even in a cloud of fog.

The village people in the Tyrol told me that the Chamois would be hard to approach. "They post guards when they are grazing and resting on the slopes," they warned me. My careful observations did not confirm this point. But the Chamois' habit of facing in different directions when grazing or resting serves in fact as a protective device which made it difficult to stalk the groups. In dense timber they hear and react to the noise of breaking twigs. On open, rocky slopes they feel the vibration of footsteps over a great distance. Their vision, too, is effective at long distances.

But the dwarf pine vegetation at the timberline provided good hideouts and cover for approach when I watched the Chamois in the daytime and at dusk. At times when the light snow cover was frozen over, I could not avoid making a noisy step, and then followed the shrill warning whistle of a female and in a few seconds the whole flock would be gone, with only an occasional falling rock to indicate their direction. Unlike our American Elk, the Wapiti, the Chamois do not travel far after a disturbance. They reappear in the vicinity soon and, being curious by nature, they sometimes even try to see the intruder. Most major slopes in the part of the Tyrol where I was working have their "steady" groups of Chamois. A number of "pulpit seats" – that is, blinds on trees – have been built for the master of the hunt. My observations were often made from these; before daybreak I would

enter such a blind and wait for the resident flock to appear.

An interesting Chamois story was told me by Prof. Hediger of the Zurich Zoo. Since Chamois are typical of the alpine region, it was planned to exhibit a few in the Zoological Gardens of London. The Swiss government graciously donated a group, and they were crated, loaded into an airplane and sped on their way. But fate had it otherwise, according to the story as I heard it. The plane crashed in the Jura mountains in southeastern France. Everyone was reported killed. But a few years later, Chamois were revealed, in a scientific paper, as being found in the Jura mountains. When the airplane crashed, the crates had broken and the Chamois alone had survived the disaster, had established themselves and multiplied, for conditions were much to their liking. A unique method of introduction into a new habitat, indeed!

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# Our Upside Down Catfish Grow Up

By JAMES W. ATZ

Just six years ago the Aquarium acquired its first upside down catfish and since that time a tank containing two or more of these fish has been one of the features of our exhibition in the Lion House. During that time, thousands of visitors have looked and wondered at fish that spend much of their time swimming or resting belly up.[1]

For us, too, our upside down catfish have lost none of the fascination they had when we first saw them in September of 1950. Despite the fact that they have been living under our noses, so to speak, all this time and we have since learned that there are quite a number of other fishes that at one time or another voluntarily turn upside down for considerable lengths of time, the fundamental peculiarity continues to intrigue us. It is, indeed, as if there were a race of men who habitually walked on their hands.

For one thing, we wanted to find out whether the behavior of the fish would change as they got older. Three French biologists, who studied a closely related species, described how these catfish at first swam normally, but as they grew they more and more frequently took an inverted position. The fish seem to dislike this change, because they appeared to struggle to stay right side up — an effort that became less and less successful as time went on. Finally they remained upside down all of the time. We have witnessed no such change as this in our species of fish. When we first received them, at a size of not quite an inch and a half, they could turn from an upside down position to a more ordinary one and back with equal ease, and they swam equally well either way. The turn might be made as a 180° roll around the long axis or as a loop or dive, that is, nose up or nose down. This still holds true today, when the fish are fully six inches long. Although much of the day or night is spent upside down or in other peculiar positions, the fish can, and frequently do, swim around their tank in the more usual manner, resting back up, like any ordinary catfish.

We also wondered whether our upside down catfish would change color as they grew up. Fishes typically have dark-colored backs and light bel-

1 An account of these upside down catfish, by the present author, appeared in Animal Kingdom, Vol. 54, No. 1, pp. 18-21, Jan.-Feb., 1951.

*This is how our Upside Down Catfish looked in 1951. They were only about 1½ inches long when they came from the Congo.*

*Now, in 1956, the catfish ha grown to 6 inches, but their b havior has not changed. Th name is* Synodontis nigrivent

lies. This *countershading,* as it is called, serves to make the creatures less conspicuous when viewed from the side or from above or below. It might be guessed that a fish that lived upside down would show the reverse coloration; that is, would have its belly darker than its back. As a matter of fact, such a reversed pigmentary pattern is found on three species of upside down catfishes, all of which are known to swim on their backs, but it is not true of two others. The latter exhibit the more conventional coloration even though they have been seen swimming about in an inverted position. Our upside down catfish, the sixth species to be reported to have this unusual habit, belong to the second group. They are a uniform tan in color, covered from back to belly with heavy but intricate chocolate brown markings. The belly is neither more nor less heavily pigmented than the back. This has been the general pattern of their coloration from the beginning, although as babies the brown pattern was not as well developed and they showed light blotches here and there instead.

The behavior of our fish provides a clue to this striking difference in pigmentation. With regard to their color pattern, one might say they are neutral with neither back nor belly being darker. This same lack of emphasis is found in their orientation behavior: they regularly employ both upside-down and right-side-up positions. We do know that the species that eventually was forced to remain upside down continuously — the one described by the three French investigators — has reversed coloration. Perhaps only those catfish that remain more or less permanently upside down have adopted an inverted color pattern to match their inverted orientation.

Since 1950, when we obtained our first upside down catfish, we have become much more aware of the problem of how fishes orient themselves in their three-dimensional world and we have learned that there are a good many species that swim or rest in an inverted position. First of all, quite a few fishes lay their eggs on the under side of leaves, shells and stones, but these might be considered a special case, since they only assume an inverted position while spawning. Some of these fishes watch over their eggs, however, and must turn over each time they wish to brush them with body and fins in order to keep them clean. We have watched a male Johnny Darter spend as long as eight minutes at a time upside down while he swam back and forth over the eggs fastened to the roof of his nest.

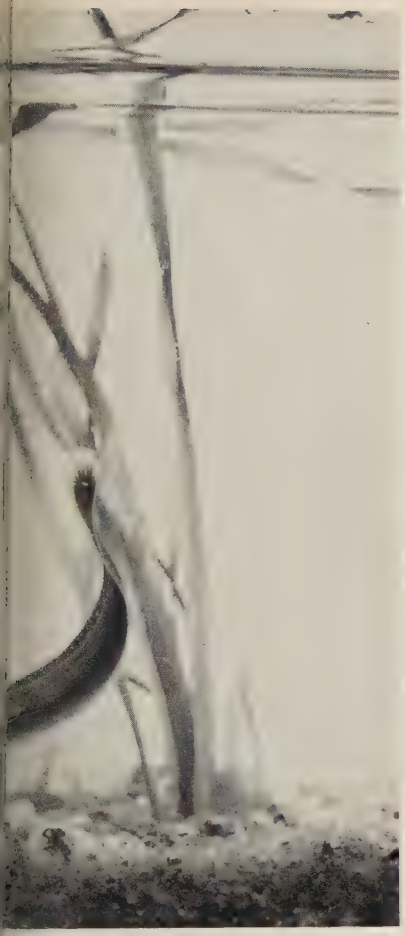
There are also a number of fishes that habitually or occasionally take upside down positions in crevices, holes or overhanging projections. There are many such places in coral reefs, and inquiries made of skin-divers and aqualungers who have explored these places have revealed that fishes lurking upside down in such out-of-the-way spots are unusual but not rare. The small but gorgeously colored Fairy Bass (*Gramma hemichrysos*), for example, very frequently rests with its belly up against some overhanging coral rock, according to Frank Trevor and Carleton Ray, both of whom are experienced underwater divers and students of fish behavior. Mr. Ray also informs us that he has observed at least half a dozen other Bahaman species behaving in a similar manner. The Treefish (*Sebastodes serriceps*) of the California coast is another habitual "upside downer." We have it on good authority that the Shedd Aquarium in Chicago exhibited for some time a Zebra Fish (*Pterois volitans*) that regularly took up an inverted position under a narrow shelf in its tank. We were therefore not too surprised when we recently saw a Zebra Fish in an underwater motion picture swimming along upside down.

The fishes mentioned in the preceding paragraphs may swim upside down for short distances, but they seldom, if ever, do so for considerable distances out in mid-water. As far as we know, only the upside down catfishes of Africa regularly do this, although there is a report that one of the South American armored catfishes also at least occasionally does so. A recent report also tells of a Striped Mullet seen swimming upside down near Miami Beach, but this is certainly abnormal behavior for such a well known food fish. Most fishes never turn belly up unless severely injured or dying from some other cause. Why certain fishes regularly turn upside down and how they can thrive in such a topsy-turvy existance are questions that still puzzle us.

# ZOO NEWS IN PICTURES

Photographs by SAM DUNTON

This curious creature from the Belgian Congo and Angola regions of Africa is the **EEL-CAT,** *Channallabes apus,* the first one we have exhibited at the Aquarium. Although it looks so much like an Eel, it is a true Catfish — as evidenced by its whiskers. It has, however, lost all evidence of pectoral and ventral fins. Our specimens are a little less than a foot in length. Very little is known of its mode of life, its feeding habits or reproduction.

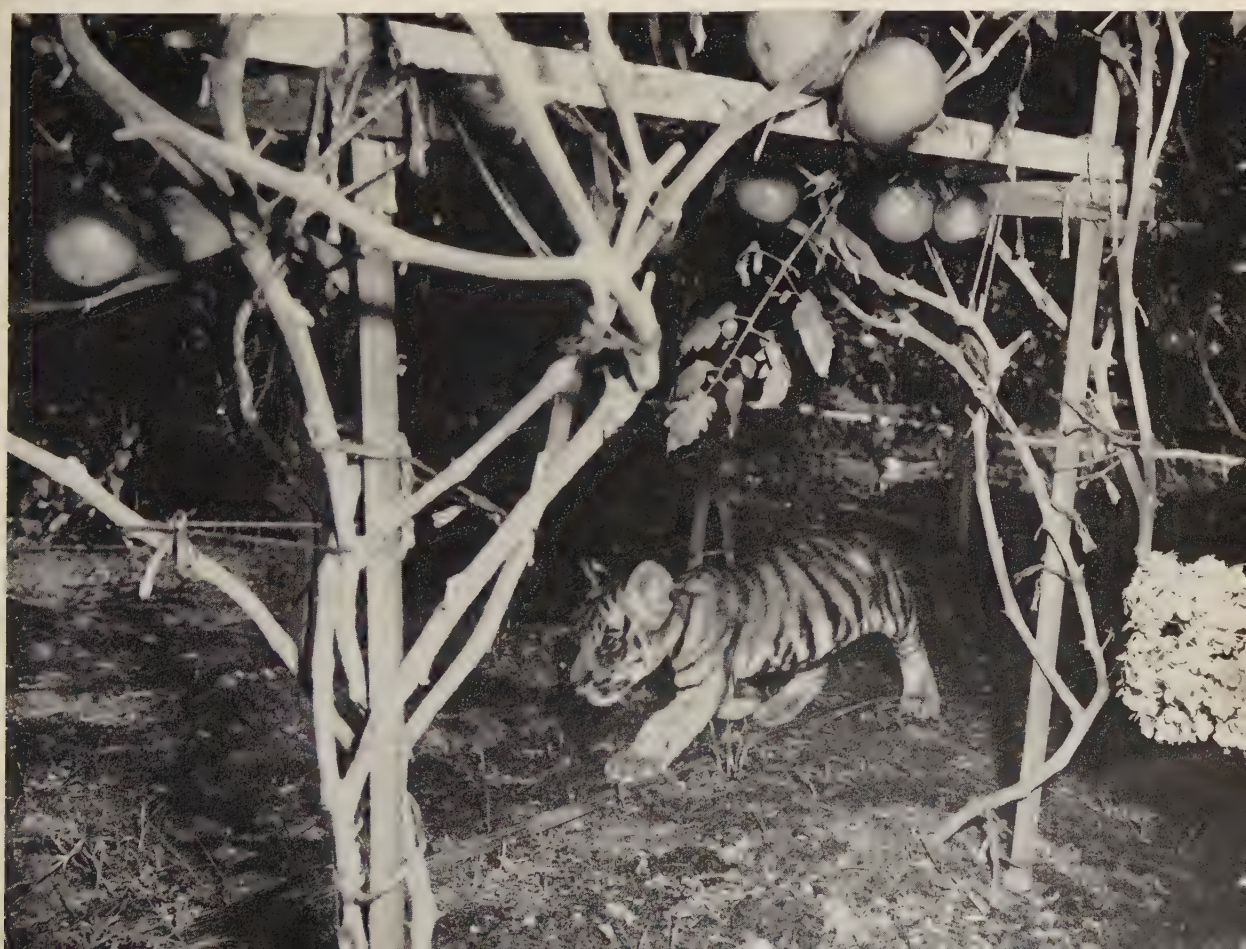


No **DUCKBILL PLATYPUS** baby this year! Early in August the bank of earth at one end of our Platypusary was opened – after all hope had been abandoned that Cecil and Penelope would produce offspring this season – and this meandering tunnel was found. The Platypuses were observed courting for the first time on June 16, and courtship continued with a good deal of fervency for nearly a month. Penelope paid no attention to the eucalyptus leaves that were put into the water of her pool, and when courtship stopped and she gave none of the signs of nest-building, we decided that once again the Platypus affair was coming to nothing. Whether the animals will be beyond breeding age next spring, when they will have been ten years in the Zoo, is unknown, but they will be given every chance. They came to us from Australia in April of 1947. White sand has been poured on the floor of the tunnel to emphasize it.

**GRANT'S ZEBRA** colt, born in the Zoologi-
rk on August 19, will be sticking close to its
r for some time yet, but it is likely to have
er circle of acquaintances next year. We are
ng of introducing it to the African Plains
t, where it will have the companionship of
ng Zebra named "Jesse," given the run of
ains this past year. The new colt is the first
rn to our pair of Grants. The father came to
m the Tanganyika region of Africa in 1952.

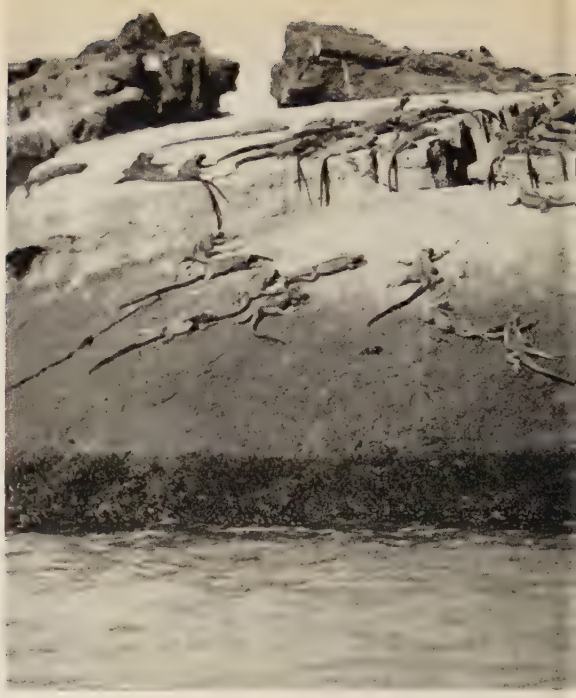
For the second time we have a **KORI BUSTARD,** a large and handsome bird from South Africa, which has not been seen in the Zoological Park since 1944. An insect-and-greenstuffs feeder, the Kori is much hunted on the African plains and is a wary and difficult bird to stalk. In the Zoological Park, its difficulties are of a different order; it is notoriously fragile and must be handled with the greatest care to prevent the breaking of legs or wings – or, better, not handled.

Castor and Pollux, the **TIGER CUB** twins born to Dacca, our prolific Tiger mother (they are her 26th and 27th offspring) have been having a wonderful summer. Because it was necessary to remove them from their mother soon after birth, they have been hand-reared by Mrs. Helen Martini in her home and garden near the Zoological Park. With a large yard to roam in almost at will (under Mrs. Martini's watchful eye, of course) they have developed into strong and sturdy youngsters. On five afternoons a week during the summer they have been fed in public by Mrs. Martini, in the north outside bay in the Lion House, but now that they are four months old, they are big enough to go on regular exhibition by themselves. They will not, however, be with their mother.



# LIZARDS OF THE SEA

By JAMES A. OLIVER



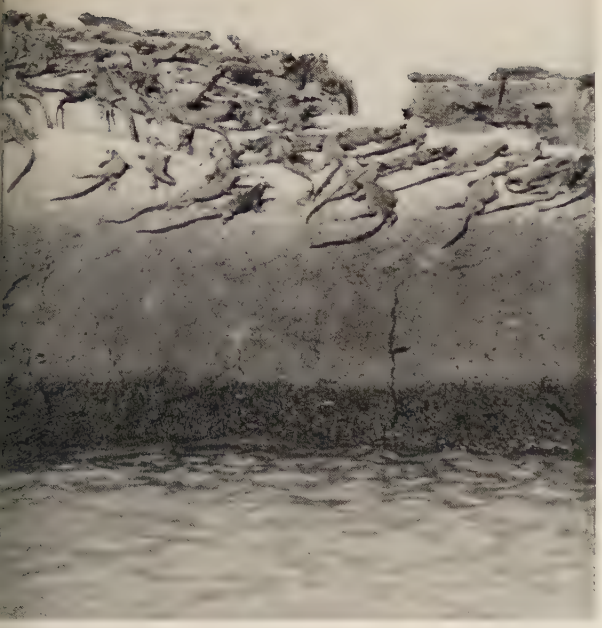
When Charles Darwin visited the Galapagos Islands in 1835 he met one of the world's most unusual assemblages of animals and plants – organisms that contributed substantially to the formation of his theories of evolution and thus made a lasting impact on the thoughts of man. One of the most bizarre forms he encountered was the Marine Iguana (*Amblyrhynchus cristatus*), the only living lizard adapted for life in the seas.

In the account of his visit to the islands Darwin wrote:

"It is extremely common on all the islands throughout the group, and lives exclusively on the rocky sea-beaches, being never found, at least I never saw one, even ten yards in-shore. It is a hideous-looking creature, of a dirty black colour, stupid, and sluggish in its movements. The usual length of a full-grown one is about a yard, but there are some even four feet long; a large one weighed twenty pounds: on the island of Albemarle they seem to grow to a greater size than elsewhere. Their tails are flattened sideways, and all four feet partially webbed. They are occasionally seen some hundred yards from the shore, swimming about; and Captain Collnett, in his Voyage, says, 'They go to sea in herds a-fishing, and sun themselves on the rocks; and may be called alligators in miniature.' It must not, however, be supposed that they live on fish. When in the water this lizard swims with perfect ease and quickness, by a serpentine movement of its body and flattened tail – the legs being motionless and closely collapsed on its sides. A seaman on board sank one, with a heavy weight attached to it, thinking thus to kill it directly; but when, an hour afterwards, he drew up the line, it was quite active."

Darwin's account provides a good introduction to this interesting lizard, although his description of it as "a hideous-looking creature" suggests a personal antagonism to reptiles. Much more sympathetic is William Beebe's designation, "these splendid saurians." Whether you go along with Darwin on the appearance of the Marine Iguana or whether you share Beebe's more cordial feelings, I think most of us can agree on the uniqueness of these lizards.

William Beebe, John Tee-Van and other members of the Department of Tropical Research's *Noma* Expedition arrived at the Galapagos Islands almost a century after Darwin's visit. They, too, were impressed by these marine reptiles, so much so that they collected a number of them and brought them back to the Zoological Park where they were exhibited at the spring Garden Party of 1923. From his experiences with the lizards Dr. Beebe wrote, "I discovered two very interesting things about them – they could not be made to bite, and they absolutely refused all food in captivity." It has been more than a quarter of a century since these remarks were made, but their accuracy remains unaltered.



***ABOVE — Large numbers of Marine Iguanas may be found basking on this favorite ledge in Webb Cove, Albemarle Island. RIGHT — A sooty black Marine Iguana received recently.***

Failure to induce the lizards to eat in captivity is not the result, as it sometimes is, of a lack of knowledge of their natural food. Darwin, Beebe and others have made first hand observations on their feeding habits. Darwin wrote, "I opened the stomachs of several, and found them largely distended with minced sea-weed (Ulvae) which grows in thin foliaceous expansions of a bright green or a dull red colour. I do not recollect having observed this seaweed in any quantity on the tidal rocks; and I have reason to believe it grows at the bottom of the sea, at some distance from the coast. If such be the case, the object of these animals occasionally going out to sea is explained. The stomach contained nothing but the sea-weed." Dr. Beebe observed on Indefatigable Island that "when the water began to recede they crawled slowly down and munched at the tufts of exposed sea-weed."

Mr. Otis Barton, designer of the Bathysphere and a longtime associate of the Society, recently sent us three excellent young specimens of Marine Iguanas, the first we have had in many years. Since their arrival we have been trying to disprove Dr. Beebe's statement about their refusal to eat in captivity. To date his statement continues to be true, but we have not given up hope and still have several ideas to try on them. It is always a challenge to overcome an individual's reluctance to eat in captivity. It is more so when this reluctance appears to hold for all or most members of a species. So far we have offered the lizards what seemed to us appetizing – both in looks and smell – salads of several kinds of sea-weeds, with and without chopped and whole clams. These offerings have been presented in and out of salt and fresh water. Something is still lacking – perhaps a characteristic odor, color, shape or consistency of some normal food substance. Or, perhaps, we are not presenting the food in just the right manner. All too often with finicky feeders, it is a matter of some slight circumstance we may learn about only by accident,

but which is necessary to release the feeding response that stimulates the animal to eat. Meanwhile the three Marine Iguanas are on exhibition in the Reptile House and are attracting considerable interest. They do not show any external effects of their prolonged fast.

The Marine Iguanas have been studied most recently in their native habitat by Dr. Irenäus Eibl-Eibesfeldt of the Max-Planck Institute in Austria. Many previous observers have reported seeing the lizards in large herds of several hundred individuals. Eibl-Eibesfeldt found these

large herds were composed of many smaller herds, each of which consisted of one male and several females. The polygamous males maintain definite territories which they defend vigorously against the intrusion of other males. Dr. Eibl-Eibesfeldt says, "These fights are highly ritualized and follow certain rules. First the two males show a certain threatening behaviour, then they try to push each other off the rocks, using their heads." The top of the head is covered with raised, knob-like scales that are supported beneath by bony nodules on the skull. Occasionally when a male enters another's territory without the preliminary butting and pushing, the defending male may bite the intruder. Otherwise biting is seldom used in these fights. Eibl-Eibesfeldt found that males stay close to their territories when on land and return to them if forcibly removed.

Darwin performed a simple experiment with one of the lizards which also suggests a good sense of orientation in the water. He wrote, "I threw one several times as far as I could, into a deep pool left by the retiring tide; but it invariably returned in a direct line to the spot where I stood. It swam near the bottom, with a very graceful and rapid movement, and occasionally aided itself over the uneven ground with its feet. As soon as it arrived near the edge, but still being under water, it tried to conceal itself in the tufts of sea-weed, or it entered some crevice. As soon as it thought the danger was past, it crawled out on the dry rocks, and shuffled away as quickly as it could. I several times caught this same lizard, by driving it down to a point, and though possessed of such perfect powers of diving and swimming, nothing would induce it to enter the water, and as often as I threw it in, it returned in the manner above described."

The Marine Iguana belongs to a large family of lizards known as the Iguanidae. Most members of this family are small to moderate in size, but of the 60 to 65 genera comprising the family at least six include forms nearly as large or larger than the Marine Iguana. All of these large forms are known as iguanas. The word itself is a Spanish term of Indian origin and is generally applied throughout Latin-America to any large lizard. Probably the best known iguana is the large, green, tree-dwelling species usually called the Iguana, the Common Iguana or Green Iguana and whose scientific name is *Iguana iguana*. It is from this species that the family name is derived. The Green Iguana is a suitable standard bearer for the family. It attains the greatest length of any member of the family, with maximum overall dimensions of six to seven feet. The long, whip-like tail takes up most of this length. The Green Iguana is found in wooded areas, generally near water, from Mexico to and including South America and the West Indies. These large lizards are hunted for food over most of this area and are seen frequently in native markets where they usually are called "chicken of the tree." They also are sold alive in large numbers to carnivals and reptile shows where they are exhibited as "Chinese dragons." The row of long, spine-like scales along the middle of the back and the large dewlap on the throat enhance the impressive appearance of this lizard.

The Green Iguana, like its marine relative in the Galapagos Islands, is an excellent swimmer, but it confines its activities to freshwater rivers and swamps. It feeds on leaves, blossoms and succulent seeds of plants. The adults are usually seen in large trees, often on limbs overhanging water. When pursued, wounded or disturbed they have been known to jump or dive from great heights. When landing in water, they swim away rapidly, usually underwater. The powerful tail propels them through the water and the legs are not used in swimming. Iguanas can remain submerged for long periods of time.

All of the large iguanas can swim well when occasion demands, but the Marine and the Green are the best swimmers. In light of these abilities it is interesting to note the difference in the behavior of the two forms. Many observers have reported that it is almost impossible to drive the Marine Iguana into the sea and that they enter the water only on their own volition. Apparently they had no enemies on land until man came along to disturb them, and sharks and other marine predators constituted their main danger. The Green Iguana, on the other hand, heads for the water as soon as it is disturbed – to it the water represents safety when danger approaches.

In addition to the Marine Iguana there are two large land-dwelling iguanas on the Galapagos Islands. These are stockier species and live inland in burrows among the rocks and low trees of the

***The Green Iguana is the longest of its family, reaching a length of six to seven feet. This one was a pet in our Reptile House.***

*Photo Jack Layer, Journal-American*

islands. The better known of the species is called the Galapagos Land Iguana (*Conolophus subcristatus*). In the West Indies there are several species of land iguanas, the largest being the Cuban Iguana (*Cyclura macleayi*), which is very heavy bodied and may attain a length of four or five feet. It is probably the heaviest of the iguanas, sometimes weighing more than 30 pounds. The Rhinoceros Iguana (*Cyclura cornuta*) of Hispaniola is the most impressive-appearing of the West Indian species. It gets its name from the prominently raised, horn-like scale on the snout.

The Spiny-tailed Iguanas of the genus *Ctenosaura* occur from northern Mexico to Panama. The several species are mostly under three feet in length. Their common name comes from the rows of spine- or spike-like scales that arm the tail. All of the big iguanas can use their tails as effective defensive weapons. The long whip-like lash of the Green Iguana can raise a painful welt on the arm of a man or can knock over a small predator. Similarly the spike-covered tails of the Spiny-tailed Iguanas can painfully lacerate the nose of a would-be mammalian predator.

All of the large iguanas mentioned so far are forms living in the tropical and subtropical areas of the Western Hemisphere. The family Iguanidae consists almost entirely of forms found in the Americas. The animals and plants of the Galapagos Islands are related to species in Central and South America and therefore the islands are considered in the American area. The only members of the family living outside of this area are found in Madagascar, Fiji and Tonga. The seven species on Madagascar are all small forms, but the one on Fiji and Tonga is a good sized iguana, reaching a length of two to three feet and is known as the Fijian Iguana (*Brachylophus fasciatus*).

The stories of how the iguana got to Fiji and Tonga, or why the family is found on Madagascar but not in Africa, are interesting zoogeographic considerations too complex to relate here. Simply stated, the history of the Iguanidae goes back more than 60 million years and the fossil record shows the family was once more widely distributed. Its representatives in the Old World have become extinct except for the small remnants on Madagascar and the Fijian Iguana, also living on islands. Islands seem to have provided suitable sanctuaries for these large lizards. Four of the six groups of large iguanas living today are found on islands. Among these, the two from the Galapagos have had special interest for herpetologists and zoogeographers, but the Marine Iguana remains the most unusual and interesting of all.

# THE AMERICAN BEAVER

(Part 2)

By ALBERT R. SHADLE

*Biology Department, University of Buffalo*

In starting a new home, Beavers must be assured of a plentiful water supply, such as a lake, a big pond or a stream. Where there is an abundance of deep water, it is unnecessary for them to build dams. In small streams and brooks, they must build up dams which will store and conserve the water so that there is an adequate amount throughout the year, and particularly in the fall and winter. The water must be deep enough for the storage of a winter's supply of food and too deep for the pond to freeze solid in the most severe winter weather.

If the new home is in a small stream where a bank den can be built, the construction of the dam and the den will usually be carried on simultaneously. The easiest and quickest way for the Beavers to build their living quarters is to dig a bank den with two or more burrows leading from it for entrance and escape. This is possible when the bank beside their lake, pond or stream rises four or more feet above the level of the water. The site chosen is usually among roots of shrubs or a tree standing on the bank.

A foot or more below the surface of the water, the Beavers start to dig a burrow back into the soil and any roots that they encounter are promptly cut off with their incisor teeth and removed. The burrow or tunnel is extended several feet into the bank and sloped upwards until it is several inches above the level of the water which rises in the burrow to the same height as that in the pond outside. At the dry upper end of the tunnel, a larger cavity or den space is excavated for living quarters. This room is probably about four feet or more in diameter and fifteen to eighteen inches in height. After their nocturnal work and other activities, the Beavers are safe here from the attacks of other animals and can rest and sleep in the daytime, for the entrances are always below the surface of the water and few animals would dive down and follow the water-filled tunnels to get up into the living quarters.

When the construction of a dam is begun, brush and pieces of limbs of various kinds, sizes and lengths are cut and dragged or towed to the building site and located in the stream. The Beavers also carry mud, wet leaves, pieces of sod, moss and other materials. As these are gathered up, they are firmly pressed against the Beaver's

breast by its fore legs and paws. When carrying mud, etc., to place on the brush, the Beaver can often swim with it, but if the water is too shallow to swim, it walks along semi-erect to the dam where the mud or other soft material is placed so that it fills in the spaces among the limbs and brush. More and more "arm-loads" of the soft materials are brought, additional brush and pieces of limbs are added, and more mud is filled in to solidify the structure and to prevent the dam from leaking.

As the structure begins to hold back the stream, the water rises and spreads, forming a Beaver pond by the den. As the water continues to rise and starts to flow over the dam or around its end, the Beavers promptly bring up more sticks and mud which lengthen or raise the dam and also stop the loss of water.

Most of the mud and other soft materials, such

as leaves, weeds, roots, etc., used to chink the interstices, are dug from the bottom of the pond and this excavating deepens the pond and gives space for greater storage of water. As the Beavers gradually raise the crest of their dam and widen its base, they take advantage of each slight rise in the ground, of old logs, big stones, fallen trees, or anything else which can be incorporated in the dam. The gradual increase in the height and length of the dam holds back more water and the pond deepens and spreads over a larger area. As the water rises in the pond, it also gradually rises in the burrows and this brings about reactions from the Beavers.

Dens in low banks often go through an interesting series of modifications which materially change the surroundings and result in the successive transformation of the den from a simple "bank den" to a "bank lodge" and finally a lodge completely surrounded by water, an "island lodge." This is all due to the damming and the rise of the water level in the pond. These modifications occur somewhat as described below.

When the rising water in the bank burrows threatens to flood the living quarters and the remaining soil of the den roof is too shallow to permit further excavation of the roof without thinning and weakening it too much for safety, the Beavers begin to convert the bank den into a bank lodge. They carry sticks, limbs, mud, etc., up on the bank and place them directly above the den, thereby thickening the roof very appreciably. Sometimes a cone-shaped pile two or more feet in thickness is built above the den. With this additional roof protection, the Beavers begin to dig away the remaining soil of the roof, allowing the dislodged material to drop to the den floor. Thus by digging away the ceiling and adding the material to the floor, they gradually build up the floor level of the living quarters by several inches. When all the original roof is dug away and they begin to encounter some of the sticks and mud they have previously piled over the den, part of that mud, too, has to be dug loose and protruding portions of the embedded wood have to be gnawed away and dropped as chips. These also become a part of the floor and the basal portion of the lodge. With the pilings of the additional ma-

***typical "island lodge." Fresh ttings have been dragged in to ake the lodge, and a coating of ud and leaves will be added.***
*Photo by R. D. Fraser*

***This Beaver dam in the Allegheny State Park is an especially big one. It is 470 feet long, 7 feet high, is built mostly of aspen.***
*Photo by R. D. Fraser*

terial over the den and its excavation to form living quarters, the original bank den is now properly termed a "bank lodge."

Continued gradual rise of the pond level necessitates the addition of more and more material to the outside of the bank lodge and the excavation of the inside of the pile. Masses of material may be built up in a pile six feet or more high above the original bank, and may be twenty or more feet in diameter. The raising and lengthening of the dams sometimes deepens and extends the water until it completely inundates the area around the bank lodge, so that the lodge appears simply as a cone-shaped island in the pond. The lodge now may properly be called an "island lodge," a type which is usually found in low swampy areas and in ponds lacking well-defined banks high enough to provide bank lodges.

The length and height of a dam depend upon several factors, some of which are the topography of the immediate surroundings, the slope and width of the valley at that point, the size of the stream, the volume and depth of the water, and the sizes, kinds and abundance of trees and woody shrubs available close by. Dams vary in length from a few feet to more than a thousand feet, while the heights range from a few inches to eight feet or more.

Long dams and high ones require a very considerable amount of wood to make them strong enough to hold water during the heavy flow in the spring, or after a heavy rainfall. The Beavers must fell the bushes or trees, cut them up into sizes and lengths which they can handle and drag overland to the water where they can be towed to the building area and used. The size and length of the cuttings depend upon the weight and strength of the animal, the weight of the wood and the nature of the terrain over which the cuttings must be dragged and towed.

In the summer of 1951, measurements were made of 140 of the larger cuttings in an old Beaver dam in the Allegany State Park in southern New York. The longest piece was a 20-ft. 7-in. sugar maple, 2.16 inches in diameter at the base. The longest aspen section measured 13 feet 5 inches with a diameter of 3.75 inches. The longest blue beech was 9 feet 7 inches in length with a diameter of 3 inches. A 3.5-inch shadbush log was 9 feet 10 inches long and a single large elm found was 9 feet 4 inches in length with a 3.75-inch diameter.

The largest diameters were: an aspen, 6.37 inches, length 3 feet 6 inches; shadbush, 5.75 inches, length 6 feet 10 inches; blue beech, 5 inches, length 6 feet 5 inches; maple, 4.75 inches and length 11 feet 6 inches.

These measurements were made from old, seasoned, barkless wood, and it would be interesting to know what the measurements were at the time when the Beavers made the cuttings, when they were green and before the bark was removed. Naturally the diameters would have been greater and the weights considerably heavier. Such figures would also give a more adequate idea of the ability of the Beaver to handle large-sized, heavy pieces of wood.

The Beaver's heavy skeleton and the powerful muscles of the jaws, neck, limbs and body enable it to exert remarkable force in drawing, towing or handling wood cuttings. The little hand-like fore paws and strong shoulders are well adapted for pushing and turning and manipulating the cuttings where they are needed in construction. This is especially important when the Beavers are repairing a break in the dam. The large teeth and heavy neck are also quite useful in placing and anchoring a piece of wood in building or repairing.

To repair a break, the Beaver chooses a piece of wood and takes it to the dam. With its big incisors, it seizes the stick crosswise about six or eight inches from the end. It lowers its head and gives the head and neck quick strong jerks to one side, so that the short end of the stick is jabbed several inches into the wet mud around the break, thereby being anchored firmly in position. The surrounding part is then filled in with more pieces of wood, and finally chinking material is added to stop the flow of water through the opening.

When it uses long poles, the Beaver tows them to the dam, where they are dragged over the crest and left with the upper ends resting on or against the crest, and the lower ends stuck firmly in the mud below the dam. The tops of these long poles eventually become buried in the face of the dam as it is built higher. In this way they serve as props which strengthen the structure. They often measure two to four inches in diameter and six to ten feet or more in length. These pieces of heavy

*These two remarkable photographs are probably the first ever published of a Beaver carrying its young in its arms. They came to us through the kindness of Dr. H. Hediger, Director of the Zoo in Zurich, Switzerland. He wrote: "Last June we succeeded in breeding young Canadian Beavers in our Zoo, and we often observed that both of the parents carried the young back to the nest in their arms when the young had been in the water long enough. In the older literature we found two references to this habit, but I have never seen any photograph of this interesting behavior." Note that the adult Beaver makes a rack or cradle of its outstretched forelegs, and that the paws are turned outward. The animal walks more or less upright with its burden, as it would when dragging a tree section to its lodge or dam.*

*Photos by Werner Haller* *Zofingen (Aargau), Switzerland*

wood on the lower surface of the dam break the force of any water which spills over the crest, thus lessening and retarding the wear on the lower face of the dam.

Sometimes the Beaver's need for building material may be so urgent that it takes the freshly cut limbs directly to the dam and uses them without removing the bark for food. It is quite common to find long pieces of fresh green willow limbs partially embedded in the lower face of a Beaver dam. In spring, these green limbs, kept fresh by the wet mud, grow like cuttings. Roots sprout and grow into the mud, buds begin to swell along the exposed bark, and soon willow shoots are growing up on the face of the dam. However, sooner or later a hungry Beaver finds and devours these lush growths.

When the land is marshy or flat and no high ground is available for a bank den, the Beavers are forced to build a pile of wood and mud on the floor of the pond, stream or marsh, and tunnel into it to make their living quarters. During the construction of such an "island lodge" they take advantage of any cover or protected places to live until their new home is built. Having chosen the site for their new quarters, they begin to cut and bring together some of the surrounding vegetation and pile it into a heap. Almost anything at hand is used — freshly cut materials from bushes and trees, dead limbs, pieces of rotted logs, grass, sod, moss, aquatic vegetation, mud and even stones. As this mass begins to rise above the level of the water, more and more materials are added until it may extend four or more feet above the water level. By the time the pile is well above the water line, the Beavers begin a foot or more under the water to burrow up into the mass. When they have dug and gnawed their burrow up into the materials, until they are well above the level of the water, they enlarge the upper end of the burrow into a good-sized room which is used for general living quarters and for resting and sleeping when they are not active. These quarters may have two to four or more entrances, depending upon the size of the lodge and upon the number of resident Beavers, which may range from two to ten or more.

In low, wet areas, where the water level is near the surface of the ground, the Beavers may dig canals two feet or more wide and probably a foot to fifteen inches deep. Since these are used in transporting materials, they may become a part of, or the terminus of, a tote road. Canals are built largely by means of the Beaver's long-clawed front paws with which the soil and vegetation are dug loose and either pushed or carried aside until the desired amount of water stands in the canals. They are often so well done that they look almost as if they had been made by man. They may or may not be deep enough for the Beaver to swim in them, but they are a means of travel, and they also serve for the transportation of materials. They vary in length from a few feet to several hundred feet, and may be especially useful during the period of cutting and storing of food in the late summer and autumn.

In the spring, the Beavers begin to search out and cut bushes and trees for a diet of fresh twigs and bark, and as the leaves begin to grow a little later, they too are eaten. Such trees include in order of preference, the aspens (and other poplars), willows of various kinds and birches, but maples, wild cherries and several others are also taken. In southern New York State, shadbush and blue or water beech are used in considerable quantities, and alder may also be used. The bark of evergreens, such as hemlock and various pines, is used sparingly in that area.

As spring advances and grasses and aquatic plants become plentiful, the Beavers also turn to these for food. During the late spring and summer these may become major food items, even though twigs, bark and leaves remain staple foods. During the late fall when the deciduous leaves have fallen, and throughout the winter, their food consists of the bark of twigs and branches stored under the ice-covered water of the Beaver pond. Here in the water, and later under the ice, the bark on the twigs and branches remains reasonably fresh.

When aspen is cut down in the summer, the Beavers cut off the limbs and drag them, leaves and all, to their stream or pond. Under water, they will stay fresh for several day. The Beavers like to sit in the water while they feed, so in the evening they cut off a small branch and carry or tow it into shallow water. Sitting there half submerged, they grasp the leaves in both fore paws and push them into their mouths with a short, quick, jabbing motion. The incisors rapidly snip

the leaves into small bits and the flat-crowned molar teeth thoroughly grind each mouthful before the pasty mass is swallowed. When the tips of the twigs are soft and green, they too are often cut into bits and the bark and the wood chewed up together and swallowed. However, when the twigs are older and larger, and there is too much wood in them, they are cut into lengths of a foot or more for the removal of the bark. Holding such a piece of twig with both front feet, the Beaver begins to gnaw the bark from the wood. As it is nipped off, the Beaver rolls and pushes the twig across the front of its incisors like a man eating an ear of corn. The facility with which the fore paws turn and manipulate such a piece is really remarkable, and is fascinating to observe. When the bark has been completely eaten, the peeled twig is dropped. The bark may be removed from limbs and trunks which are several inches in diameter, but when it has become too tough and corky, the Beavers do not use it for food. Usually the trunks and limbs which have this very corky bark are also too large in diameter for them to handle, so those portions of the tree are allowed to lie as waste, to rot down, and again form soil.

An active Beaver colony is always evident. Freshly peeled sticks and limbs can be seen long before you are close enough to observe tracks on the piles of fresh mud where they have been working on a dam.

*(To Be Concluded)*

# News from the Conservation Foundation

### Conservation Teaching Manual Is Being Tried Out

A completed draft of the Conservation Foundation's new 400-page manual, "Teaching Science through Conservation," was presented to a large cross-section of elementary and high school teachers at teacher workshops at Antioch and elsewhere in the nation during the summer, for their consideration and comment. This manual, prepared by Martha Munzer and Paul Brandwein of the Educational staff, was received with unprecedented enthusiasm by the science teachers and will now be developed for publication.

### Water Law Symposium

Forty experts in water law and water administration from eastern and western states, together with a dozen key observers, are convening in Washington from October 3 to 6 to review the need and methodology for fundamental changes in eastern state water laws, in view of the greatly increased and competing demands for water by communities, industries and agriculture. Stephen Bergen and David Haber of the Research staff have completed two years of preliminary investigation and have selectively assembled more than a thousand pages of expert analysis of the riparian and appropriations doctrines on the rights of users. These, as well as an alternative approach of their own, have been submitted for discussion. Sixteen eastern states have appointed legislative commissions to study the need for modernization of water laws. Dr. Fairfield Osborn will personally greet the participants and emphasize the significance of the occasion.

### Whitefaces and Blacktails

Dr. Carl Koford has completed the manuscript report of his findings on the ecological relationship of prairie dogs to ground cover and cattle on the western range land. The title is "Whitefaces, Blacktails and Blue Grama." The study was jointly sponsored by the Zoological Society and the Foundation.

### New Chair of Conservation

Anonymous donors have endowed a new Professorship and Chair of Conservation at the University of Louisville in honor of Thomas Wallace, editor and crusader for the better use of all of our natural resources. The endowment totals $235,000. Dr. Osborn has been asked to serve as a member of the advisory committee appointed by the President of the University.

### New Jamaica Project Activated with British Support

A new and enlarged project, designed by Robert Snider, for extensive studies of human behavior and economic and human needs to balance population demands and resource supply on the island of Jamaica has, in addition to funds from sources in the United States, acquired the support of the British Colonial Office and the Nuffield Foundation of England.

Dr. J. M. Stycos, who conducted our earlier Jamaican studies, and Dr. Kurt Back have begun the training of local research workers. Interviews in many parts of the island are already under way. It is expected that the results of this training and the methods evolved from the project will cause additional resource and population studies in other Crown Colonies to be initiated.

### Industrial House Organ Features

A series of twelve illustrated cartoon-style "features" has been distributed to nearly five hundred industrial house organs for free use in these publications which reach an estimated million or more readers. Each unit deals with some aspect of the earth's natural resources and their relation to man and his prosperity. The complete series, each unit measuring 4 by 5 inches, is available to any "general interest" publication on request.

# BEHIND THE SCENES

## NEWS AND NOTES OF THE ZOOLOGICAL PARK, THE AQUARIUM AND THE DEPARTMENT OF TROPICAL RESEARCH

### Quentin Melling Schubert

Quentin Melling Schubert, Superintendent of Construction and Maintenance at the Zoological Park since 1944, died on August 25.

In the past twelve years Mr. Schubert supervised construction and improvements totalling more than $2,000,000 in the Zoological Park. His major jobs were the Penguin, Small Mammal and Great Apes Houses, reconstruction of the Reptile House and remodeling of the Wildfowl Pond, but his principal problems were the thousands of routine work orders that flowed into his department for execution, and on which the appearance and smooth operation of the Park depended.

Mr. Schubert, through his work and character, has left a lasting mark on the Zoological Park and will be sorely missed by his associates and his friends in the Zoological Society.

### A Correction

On Page 106 of the July-August issue of Animal Kingdom, the length of a very large Mexican Bearded Lizard in the San Antonio Zoo was stated to be nearly twenty inches. The correct length is 780 mm., or about 30¾ inches.

### The Aquarium Will Be Ready for Occupancy Soon

The "first unit" of Stage I of the new Aquarium at Coney Island went into operation on August 1 when the Parking Lot was opened for business. Last minute construction problems that must be ironed out before the building is formally turned over to the Zoological Society have delayed occupancy and the actual beginning of "housekeeping," but the end is not far off and we are still planning the opening of the new institution for next spring.

### Marco Polo Sheep Exhibited for First Time Here

A trio of Marco Polo Sheep, *Ovis poli*, arrived early in September and are now on exhibition at the south end of Mountain Sheep Hill. They are the first of these rare and large sheep we have ever exhibited. The two females and a male made themselves at home quickly and it is hoped that they will eventually establish a breeding colony. They are about half-grown. All we know about their background is that they came from the Prague Zoo, and that presumably they were captured in the Russian Pamirs when very small.

## IN BRIEF

**No Sale.** Komodo Monitors are, apparently, a good investment. We were recently offered $5,000 each for our monitors, which have been in the collection a little more than a year, but the offer was promptly and emphatically declined. They are the only Komodo Monitors on exhibition outside their native islands, and in the last few months they have been feeding voraciously and putting on weight and bulk.

**Photographic Honors.** Staff Photographer Sam Dunton was made a member of the Fellows Committee of the Biological Photographic Association of America at its Rochester meeting in August. His motion picture, on the reproduction of the King Cobra, was greatly praised.

**Those Questions!** Among recent questions asked (in all seriousness) at Question House were:

What are coyotes made of?
Why do cats eat birds?
Where is the Mozapus?
Do Giraffes have fingernails?
When was the Missing Link found?

**From the Galapagos, via Florida.** In 1928 when the late Dr. Charles H. Townsend went to the Galapagos Islands to form a collection of Giant Tortoises, it was planned to establish breeding colonies in Florida, Bermuda and elsewhere in sub-tropical climates. Various disasters intervened — a hurricane that wiped out some of the colonies in Florida, among others — and over the years a few tortoise eggs hatched, seven in Bermuda and two in Florida. Only one of the two Florida tortoises survived more than about ten years, and now it has come to us. Seventeen years old, it weighs 107½ pounds and is apparently in flourishing health. It came to us from Mr. G. F. Sirman who for many years operated the North Miami Zoo where the last colony of Galapagos Tortoises was maintained.

**Education Department Story.** The November issue of *National Geographic Magazine* will contain a well-illustrated article by Miss Marion McCrane of our Education Department on her "travelling zoo"— the small animals she takes to schools and hospitals.

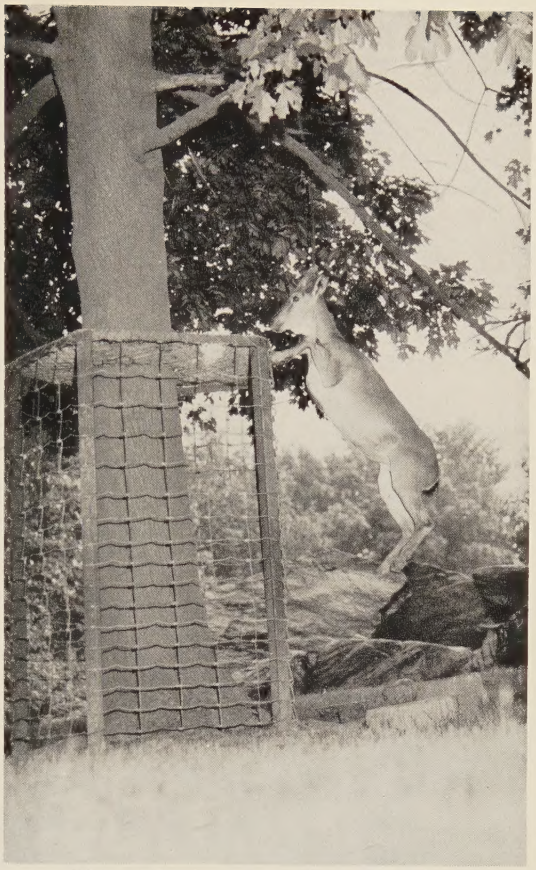


*Photo Arthur Sasse, International News Photos*

***No sign of a broken leg here! This athletic animal is our male Markhor which broke one of its forelegs while jumping around the walls of its compartment in the Federal Quarantine Station last winter. The leg healed perfectly and all summer the animals (we have a pair) have been amusing visitors by their antics on the tree guard in their yard. If the female is on the tree guard when the male wants to perch, she often leaps up in the tree and walks out on surprisingly small limbs, jumping down from a height of ten or fifteen feet. The animals are exhibited on Mountain Sheep Hill.***

**Big White Owl.** Always on the alert for rare, strange or otherwise interesting specimens, our Bird Department sifts its telephone calls and letters carefully, and birds that would represent unwanted duplicates are politely declined. But descriptions are often unintentionally misleading and it is sometimes difficult to determine whether a "big brown bird with a long beak" is just an-

other local Black-crowned Night Heron or something more desirable. However, when a lawyer telephoned from his office in Hoboken and said he had in a box a "big white owl that stood two feet tall," we sent for it, confident that it was a Snowy Owl making an unusually early appearance in this area. While the American Barn Owl that arrived as a result of this call was scarcely white or two feet tall, it was nevertheless welcome as we had not had the species since 1946.

**Hummers to London.** For the past sixteen years the month of September has never passed without at least one, and often several, Ruby-throated Hummingbirds being acquired as a result of difficulties they had gotten into on their migration southward. The past month was no exception and the first Hummer, a female, was brought in by a Bronx resident on September 7. We already had a male and since we had promised a pair to the London Zoo, they left for England a few days later.

**Phoebe II.** The young Hippopotamus named Phoebe, which came to us on July 2, 1953, as a companion to Peter II, died in July as a result of septicemia (which, mysteriously, did not attack her mate in the same compartment). We have now obtained a replacement, Phoebe II, which came on August 30 and weighed 690 pounds. Although less than half the weight of her companion, Phoebe seems to have a will and a temper of her own, and is not being dominated by the larger male.

## PUBLICATIONS OF INTEREST

SPRING ON AN ARCTIC ISLAND. By Katharine Scherman. 331 pp., 16 illus., map end-papers. Little, Brown & Co., Boston, 1956. $5.00.

Members of the Zoological Society will recall the "advance copy" of Miss Scherman's book they received at the Society's mid-winter meeting in January of 1955. At that meeting she showed a motion picture, "Spring in the Arctic," and talked engagingly about the birds, the flowers, the mammals and the people she encountered on an expedition to Bylot Island – an expedition sponsored by the Zoological Society and the Arctic Institute of North America. As Miss Scherman talks, so she writes: easily, graphically, with the small, revealing detail that makes the life of Eskimos and white men in the Far North very real for those of us in warmer climates. There were dangers and emergencies, but they are not over-played. "Spring on an Arctic Island" is entertainment, but a good deal more than that; Miss Scherman asked questions and looked under the surface of things wherever she went. – W. Br.

AN ATLAS OF ANIMAL ANATOMY FOR ARTISTS. By W. Ellenberger, H. Baum and H. Dittrich. Second revised and expanded edition. 153 pp., 288 illus. Edited by Lewis S. Brown, Exhibition Dept., A.M.N.H., New York. Dover Publications, Inc., 1956. $6.00.

This handsome volume contains all plates from the standard Ellenberger, Baum and Dittrich work on animal anatomy with 25 additional plates by other anatomists.

The superb drawings show the exterior aspect of each animal, its muscular arrangement and its skeleton viewed from the side, front and rear in various actions and in details. Fourteen species, all mammals, are treated. A useful bibliography is included.

An excellent reference book for anyone interested in the subject, whether scientist or artist. – Carl Burger.

# New Members of the New York Zoological Society

**(Between July 1 and August 31, 1956)**

*Patron*
L. A. Atz

*Life*
George R. M. Ewing
Miss Rosemary Kenedy
Pieter J. Opdyke
Mrs. C. F. Roe Slade

*Contributing*
Miss Nancy Appel
Edward Marshall Boehm
David C. Clark
Dr. Albert J. Erdmann, Jr.
Mrs. T. R. Eskesen
Mrs. Edward Immerblum
George R. Puckhafer
Mrs. Mildred B. Scales
Mrs. Fred Slavic
Mrs. Philip A. Straus
Charles J. Symington
Louis E. Walker

*Annual*
John B. E. Allen
Miss Barbara Ellen Auerbach
Sidney Baer
Robert E. Barnard
Mrs. Edward A. Cunningham
Dr. J. Richard Czajkowski
Mrs. William J. Drohan
Mrs. Albert Edelman
Hal-Curtis Felsher
Andre Stephen Gorzka
Mrs. Annemarie Heller
Mrs. Oscar Howard
Miss Dale Krasnow
Victor A. Lang
Dr. A. A. Lazzarini, Jr.
Mrs. William M. Meredith
Ralph C. Mitchell
Eugene F. Moran
Dr. Robert H. Morris
Otto Oustecky
A. Brock Park
Edmund T. Ross
Mrs. B. H. Saunders
Mrs. Henry S. Sayers
Mrs. Abbot Southall
Miss Mary C. Wheelwright